

What is claimed is:

1. A Delta-Sigma modulator, for inputting an analog input signal and
for outputting a digital output signal, comprising:
 - an integration unit for receiving the analog input signal and for
5 outputting an integrated signal;
 - a 1-bit quantizer for quantizing the integrated signal output by the
integration unit and for outputting a first quantized digital signal;
 - a N-bit quantizer for quantizing the integrated signal output by the
integration unit and for outputting a second quantized digital signal.
- 10 2. The Delta-Sigma modulator of claim 1, further comprising:
 - an error correction circuit, for digitally correcting quantization noise
by using the first and second quantized digital signals of the 1-bit quantizer and
the N-bit quantizer, respectively, and for reducing the quantization noise when
15 the Delta-Sigma modulator transforms the analog input signal into a digital output
signal of the Delta-Sigma modulator.
3. The Delta-Sigma modulator of claim 1, wherein:
 - the integration unit includes one or more stages, each stage having
20 a subtractor and further having an integrator for integrating the analog input
signal.

4. The Delta-Sigma modulator of claim 1,
further comprising a 1-bit digital-to-analog (D/A) converter for
converting the first quantized digital signal output by the a 1-bit quantizer into a
quantized analog signal; and wherein

5 the integration unit includes two or more integrating stages, each
integrating stage having a subtractor and an integrator connected in series with
its respective subtractor;

wherein each subtractor is adapted to subtract the quantized
analog signal from the analog input signal; and wherein

10 each integrator is adapted to integrate the output of its respective
subtractor.

5. The Delta-Sigma modulator of claim 4, wherein N is at least 2.

15 6. A Delta-Sigma modulator, for inputting an analog input signal and
for outputting a digital output signal, comprising:

an integration unit including one or more stages each stage having
a subtractor for subtracting a quantized analog output signal output by a 1-bit D/A
converter from the analog input signal, and an integrator for integrating an output
20 of its respective subtractor; a 1-bit quantizer for quantizing the integrated signal
output by the integration unit and for outputting a first quantized digital signal;

the 1-bit digital-to-analog (D/A) converter for converting the first
quantized digital signal into the quantized analog signal;

a N-bit quantizer for quantizing the integrated signal output by the integration unit and for outputting a second quantized digital signal;

5 a terminal subtractor for subtracting a digital error signal which is a derivative of the second quantized digital signal from the first quantized digital signal and outputting its result as the digital output signal of the Delta-Sigma modulator.

7. The Delta-Sigma modulator of claim 6, further comprising:
an error correction circuit for receiving the second quantized digital
10 signal from the N-bit quantizer and for receiving the first quantized digital signal from the 1-bit quantizer, and for correcting their quantization errors, and for outputting the digital error signal to the terminal subtractor.

8. The Delta-Sigma modulator of claim 6, further comprising:
15 a delay element for delaying the first quantized digital signal output by the 1-bit quantizer, and for outputting the first quantized digital signal to the terminal subtractor.

9. The Delta-Sigma modulator according to claim 8, wherein the error
20 correction circuit includes: a third subtractor for subtracting the second digitized output signal output by the N-bit quantizer from the first digitized output signal

output by the 1-bit quantizer; and

a differentiator for differentiating an output signal of the third subtractor.

10. The Delta-Sigma modulator according to claim 9, wherein the
5 differentiator performs a high-pass filtering of the output signal of the third subtractor.

11. The Delta-Sigma modulator according to claim 6, further
comprising:
10 a limiter for limiting the output of the N-bit quantizer and removing a DC offset between the N-bit quantizer and the error correction circuit.

12. The Delta-Sigma modulator according to claim 6, wherein the
Delta-Sigma modulator is as second order Delta-Sigma modulator adapted for
15 use as an analog-to-digital (A/D) converter for converting an analog signal to a digital signal.

13. A Delta-Sigma modulator for inputting an analog input signal and
for outputting a digital output signal, comprising:
20 a 1-bit quantizer for quantizing the analog input signal and for
outputting a first quantized digital signal;
a 1-bit D/A converter for converting the first quantized digital signal
into a quantized analog signal;

a series of input integration circuits including a first subtractor and a first integrator for integrating an output of the first subtractor, wherein the first subtractor subtracts the quantized analog output signal output by the 1-bit D/A converter from the analog input signal; and a second integrator outputs an integrated signal to the 1-bit quantizer;

a first gain element for providing a first predetermined gain to a first quantized digital signal output by the 1-bit quantizer;

a N-bit quantizer for quantizing the integrated signal output by the series of input integration circuits and outputting a second quantized digital signal;

a second gain element for providing a second predetermined gain to the second quantized digital signal output by the N-bit quantizer;

an error correction circuit for receiving first and second quantized digital signal signals from the first gain element and the second gain element respectively, and correcting the quantization errors, and for outputting a resulting digital error signal;

a third gain element for providing a third predetermined gain to the first quantized digital signal output by the first gain element;

a delay element for delaying the first quantized digital signal output by the third gain element; and

a terminal subtractor for subtracting the digital error signal output by the error correction circuit from the first quantized digital signal output by the delay element, and for outputting the result as the digital output signal of the Delta-Sigma modulator.

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14. The Delta-Sigma modulator according to claim 13, wherein the error correction circuit includes a third subtractor for subtracting the second quantized digital signal output by the second gain element from the first quantized digital signal output by the first gain element; and

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a differentiator for differentiating an output signal of the third subtractor.

15. The Delta-Sigma modulator according to claim 14, wherein differentiator performs a high-pass filtering of the output signal of the third subtractor.

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16. The Delta-Sigma modulator according to claim 13, further comprising:

a limiter operatively connected between the second gain element and the error correction circuit.

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17. The Delta-Sigma modulator according to claim 13, wherein the first predetermined gain and the second predetermined gain have the same value.

18. The Delta-Sigma modulator according to claim 13, wherein the Delta-Sigma modulator is a second order Delta-Sigma modulator and is used as an A/D converter for converting an analog signal to a digital signal.